DRAFT FINAL
EXPANDED ENGINEERING EVALUATION/COST ANALYSIS (EEE/CA)
FOR THE
McLAREN TAILINGS SITE
COOKE CITY, MONTANA

Engineering Services Agreement DEQ/MWCB 401027
Task Order Number 05

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3.0 WASTE CHARACTERISTICS AND SUMMARY OF EXISTING SITE DATA

The objective of the McLaren Tailings Site investigation was to evaluate the abandoned mine/mill wastes at the site while generating a database that meets the requirements necessary to complete a risk assessment and detailed analysis of reclamation alternatives. The initial Site Evaluation Report (DEQ/MWCB-Pioneer, 2001a) presents the results of the historic reclamation investigation activities. The supplemental reclamation investigation performed by Pioneer in 2001 is summarized in this document. Historic data from the 1993 and 2000 investigations conducted by Pioneer are also included for comparison. The data generated to support two primary tasks are summarized as follows:

Risk Assessment Data Requirements:

- Establish background soil concentrations;
- Characterize vertical and lateral metals concentration variations in waste sources and assess the 0 to 6-inch zone for direct contact and air emission potential;
- Evaluate the physical and chemical properties of the source material that may affect contaminant migration including: pH, buffering capacity, organic carbon content, and particle size distribution;
- Characterize impacts to surface water with strategically located surface water samples along Soda Butte Creek and Miller Creek;
- Characterize impacts to groundwater quality in the area; and
- Assess surface water uses and estimate other ecological uses.

Feasibility Study Data Requirements:

- Determine accurate areas and volumes of the contaminant source materials including the tailings impoundment and waste rock dump;
- Determine contaminant concentration variations and leaching characteristics of the waste (Toxicity Characteristic Leaching Procedure [TCLP], porosity, hydraulic conductivity);
- Generate representative acid/base accounting (ABA) characteristics of the tailings and waste rock;
- Assess the depth and gradient of shallow groundwater;
- Assess the hydrologic configurations of Soda Butte Creek and Miller Creek channels; and
- Determine the optional locations and soil characteristics for repository site(s) and/or cover soil borrow sites.

The principal techniques used for data acquisition in these site investigations included excavating backhoe and shovel test pits, drilling, field mapping, and soil and water sampling. Samples were collected using standard operating procedures (SOPs) that are contained in the Field Sampling Plan (FSP) (DEQ/MWCB-Pioneer, 2001b) and were analyzed according to the Laboratory Analytical Protocol (LAP) (DEQ/MWCB-Pioneer, 2001b). Analytical data were evaluated for quality assurance according to the Quality Assurance Project Plan (QAPjP) (DEQ/ MWCB-Pioneer, 2001b).

The site characterization field program included collecting solid matrix samples for the following types of analyses:

- Multi-element X-Ray Fluorescence (XRF) screening. XRF analyses were generally completed for all solid sampling intervals during the 1993 site investigation. The XRF analyses determined relative concentrations of the following elements: silver (Ag), arsenic (As), barium (Ba), calcium (Ca), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), lead (Pb), antimony (Sb), strontium (Sr), thallium (Tl), potassium (K), zirconium (Zr), rubidium (Rb), thorium (Th), and zinc (Zn). A field paste pH was also measured at most solid sampling locations.

- Target analyte list (TAL) metals via commercial laboratory. This included total metals and non-metals analyses following the Contact Laboratory Program (CLP) methods for determining the concentrations of the following elements: As, Ba, Cd, Co, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Sb, and Zn. Laboratory analyses for the TAL were all performed at the HKM Laboratory in Butte, Montana.

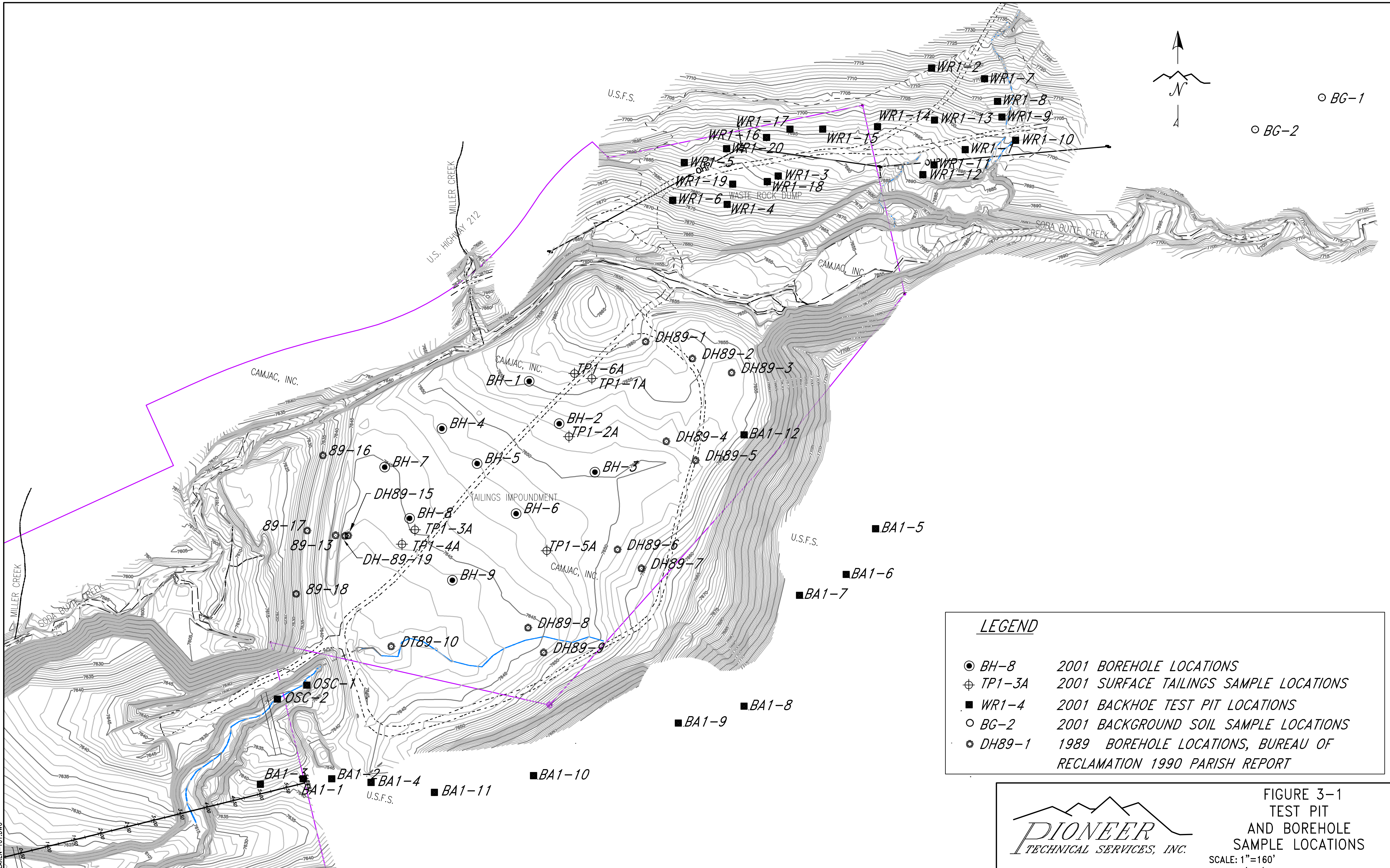
- ABA analyses including determination of sulfur fractions and neutralization potential. These analyses were all performed at the HKM Laboratory in Butte, Montana.

- Hazardous waste characteristics, determined via TCLP metals analyses. These analyses were performed by the HKM Laboratory in Butte, Montana.

The following sections discuss each individual mine waste source at the McLaren Tailings Site investigated by Pioneer in 2001. The results from this sampling effort are presented on Tables A-1 through A-8 in Appendix A. Figure 1-2 shows the location of each source and illustrates the major site features (topography, roads, waste sources, and drainage patterns, etc.).

3.1 BACKGROUND SOIL SAMPLES

Four background soil samples were collected at the McLaren Tailings Site, one in 1993 (samples 34-009-SS-1) and three in 2001 (samples BG1-1, BG1-2, and BG1-3). The background samples BG1-1 and BG1-2 are surface composite samples. Sample BG1-3 is actually a subsurface and surface composite sample collected from the potential borrow area that is representative as a background soil sample. Sample locations are shown on Figure 3-1. The total metals analytical results are presented on Table A-5 in Appendix A.



LEGEND

BH-8	2001 BOREHOLE LOCATIONS
TP1-3A	2001 SURFACE TAILINGS SAMPLE LOCATIONS
WR1-4	2001 BACKHOE TEST PIT LOCATIONS
BG-2	2001 BACKGROUND SOIL SAMPLE LOCATIONS
DH89-1	1989 BOREHOLE LOCATIONS, BUREAU OF RECLAMATION 1990 PARISH REPORT

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FIGURE 3-1
TEST PIT AND BOREHOLE SAMPLE LOCATIONS

SCALE: 1"=160'
DATE: 1/14/02

3.2 MINE/MILL WASTE SOURCES

3.2.1 Waste Rock Dump

A pile of waste rock or unprocessed ore lies at the surface of the northeast end of the McLaren Tailings Site. The mining company stockpiled their ore on the far east end, approximately where the Daisy Road crosses the Beartooth Highway. Upon closure of the site, the mill, located near the west end of the waste rock pile was demolished. The ore stockpile and miscellaneous debris was razed during post reclamation activities at the site.

The waste rock dump encompasses approximately 5 acres with an estimated volume of 56,200 cubic yards. Pioneer collected two subsamples from the waste rock dump in 1993. One composite sample from the waste rock was submitted to the laboratory for metals and ABA analyses (34-004-WR-1). Tables A-5 and A-6 in Appendix A present the analytical results from the 1993 inventory samples.

Twenty test pits were excavated through the waste rock dump by Pioneer in 2001. Three composite samples were collected, including one surface and two subsurface samples. The surface composite sample (WR1-1) was analyzed for total metals as shown on Table A-5 in Appendix A. The subsurface composite sample (WR1-2) and the surface and subsurface composite sample (WR1-3) were analyzed for agronomic parameters, TCLP, physical parameters, total metals, and ABA analyses. The results are shown on Tables A-2 through A-6 in Appendix A.

ABA and agronomic data were obtained for the waste rock for reclamation scenarios involving stabilization and revegetating in-place. The ABA and SMP buffering capacity results indicate that the waste rock is considered a potential acid producer and up to 520 tons of lime per acre would be required to successfully establish vegetation on this material, assuming a 12-inch depth of incorporation (see Table A-6 in Appendix A). Organic amendment of the dump material is advised due to the relatively low organic matter content (1.9 percent [see Table A-2 in Appendix A]).

Fertilizer recommendation analyses provided the following results for the waste rock: 35 pounds nitrogen required per acre; 25 pounds phosphate required per acre; and 33 pounds potassium required per acre (see Table A-2 in Appendix A). The breakdown of the revegetation requirements as presented above, should be considered preliminary at this time (for planning purposes only). If the waste rock is revegetated in-place, it will be re-sampled and the results will be re-evaluated after construction activities have been implemented and the dump has been recontoured, amended, and prepared for vegetation.

As shown on Table A-4, the waste rock soils are generally sandy clay in texture. Extensive iron staining on the surface is evident, and iron pyrite deposits are visible over most of the area. The presence of old timbers, other wood scraps, and metal refuse are visible and suggest that additional buried solid wastes/debris may be present in this area.

Concentrations of the following metals are significantly elevated above background greater than three times (>3X) in the waste dump: Cd, Cu, Fe, and Ag (see Table A-5 in Appendix A).

3.2.2 Tailings Impoundment

The tailings impoundment is located directly downgradient and to the west of the mill site. The tailings impoundment covers an area of approximately 12 acres with an estimated volume of approximately 239,000 cubic yards (including existing soil cover and earthen dam embankment). On September 21, 2000, Pioneer hand-augered four holes into the tailings impoundment where there was a general lack of information from previous studies. The purpose of the 2000 borings was to confirm previously collected data, to help quantify the volume of tailings, and to obtain physical data parameters. The physical data from these borings is presented on Table A-4 in Appendix A.

The tailings impoundment was again drilled as part of a geotechnical investigation conducted by Pioneer on September 17 and 18, 2001. The purpose of the 2001 borings was to evaluate engineering properties associated with stabilizing the tailings in-place. The properties were used to determine possible Soda Butte Creek channel configurations and their accompanying slope stabilities. Nine borings were augered to depths ranging from 16.4 feet to 30.5 feet below ground surface with a CME 550 drill rig. Each of the borings advanced through a soil cap, into tailings, and bottomed out in native sandy gravel.

Table A-1 in Appendix A describes the location of each borehole, the layering observed in each borehole, and the samples collected in 2001. The locations of the borings are depicted on Figure 3-1. A fence diagram incorporating the BOR's 1989 investigation and Pioneer's 2001 investigation is included on Figure 3-2. Boring logs from the 1989 and 2001 investigations are included in Appendix B. Photographs from the 2001 sampling event are provided in Appendix C.

As indicated on Table A-1 in Appendix A, groundwater was encountered in six of the nine borings drilled in 2001. Groundwater was absent in the three northeast corner holes (#1, #2, and #4). In Borings #3, #5, and #6, groundwater was encountered below the tailings in the native sandy gravel. In the borings closest to the impoundment dam (#7, #8, and #9) the groundwater was encountered within the tailings.

The tailings deposits retained within the embankment are reported by numerous authors to range up to 35 feet in thickness and consist of layered silty sands, and clayey silts. In previous reports, calculated volumes of impounded tailings vary between 150,000 cubic yards and 250,000 cubic yards. Pioneer prepared a fence diagram based upon the data collected by Pioneer and others. A tailings volume was calculated based on the fence diagram shown on Figure 3-2 and resultant cross-sections (typical cross-sections of the tailings impoundment are shown on Figures 3-3 and 3-4, for illustrative purposes). Utilizing the topographic map of the tailings impoundment and data from the borings completed as part of this investigation and the 1989 investigation, the volume of tailings present at the McLaren Tailings Site is estimated to be approximately 182,000 cubic yards. This estimate does not include the volume of the dam embankment or existing soil cover.

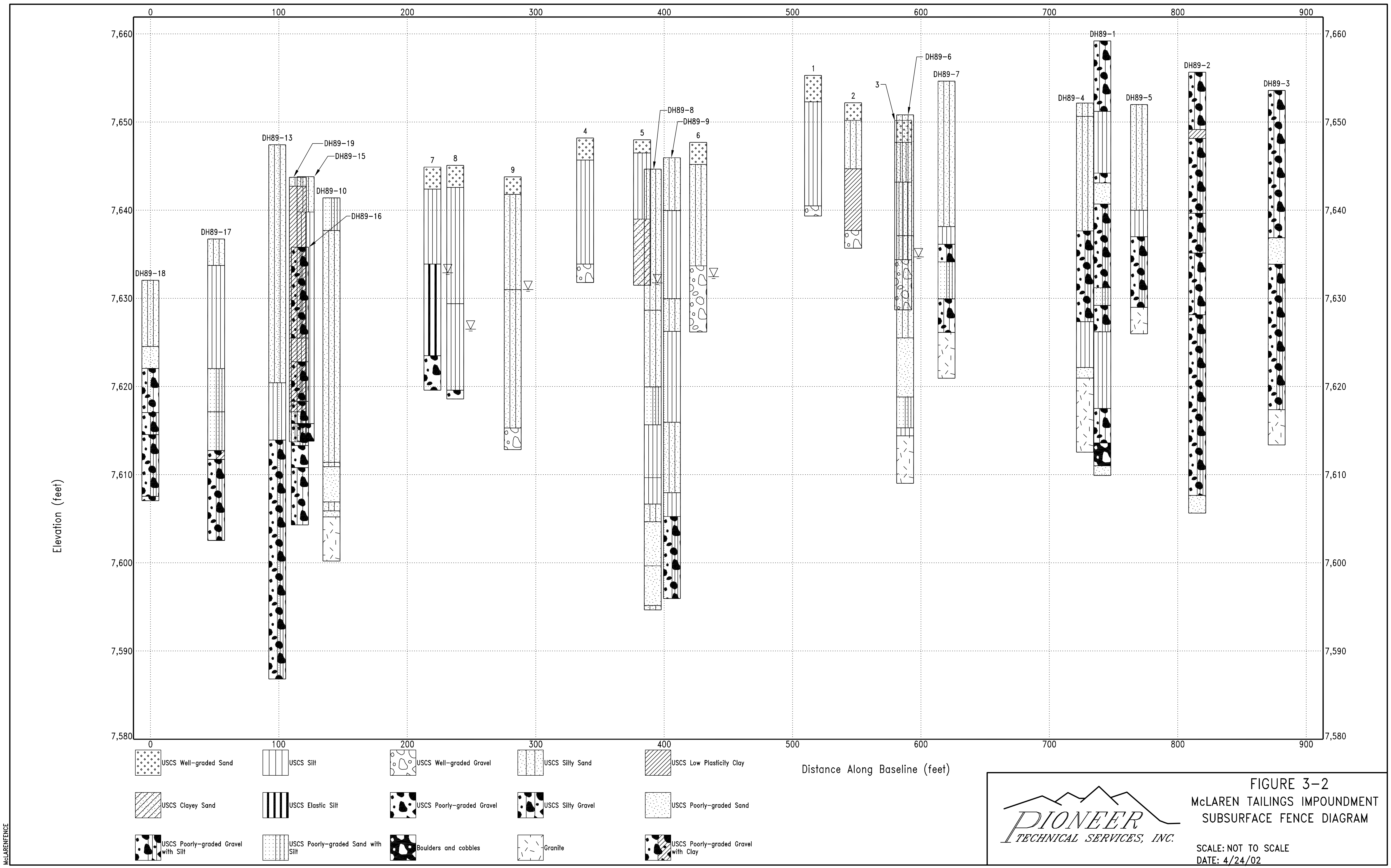

FIGURE 3-2
McLAREN TAILINGS IMPOUNDMENT
SUBSURFACE FENCE DIAGRAM

SCALE: NOT TO SCALE
DATE: 4/24/02

NOTE: REFER TO FIGURE 1-2 FOR LOCATION OF THIS CROSS-SECTION.

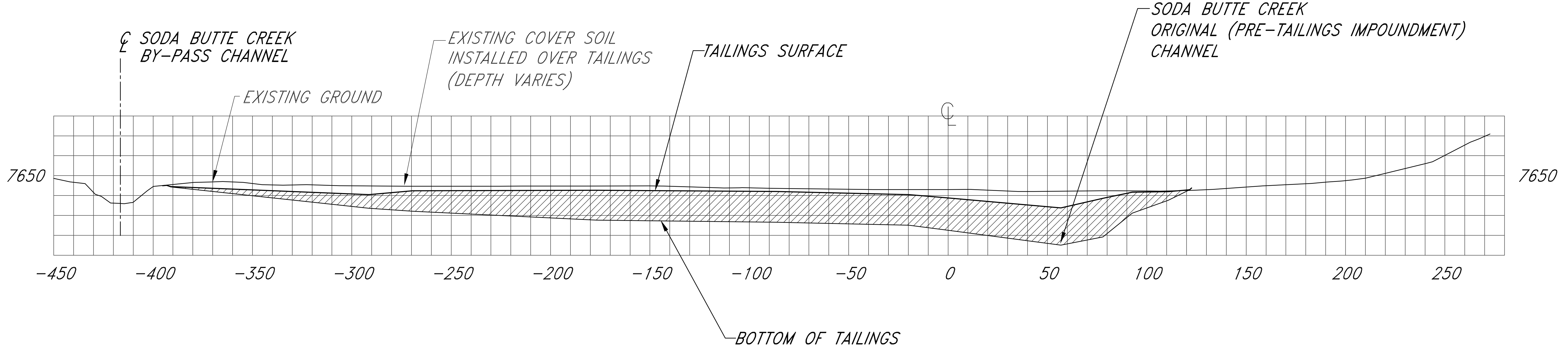

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FIGURE 3-3
TYPICAL NORTH/SOUTH CROSS SECTION OF TAILINGS IMPOUNDMENT

SCALE: 1"=50'
DATE: 5/13/02

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NOTE: REFER TO FIGURE 1-2
FOR LOCATION OF PROFILE

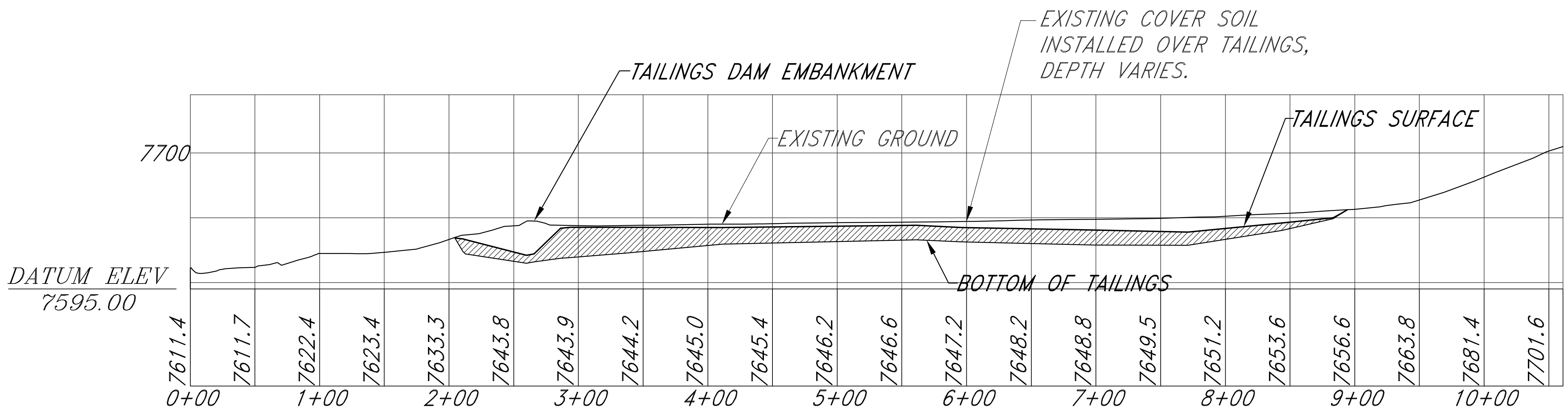

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FIGURE 3-4
TYPICAL EAST/WEST PROFILE
OF TAILINGS
IMPOUNDMENT

SCALE: 1"=100'
DATE: 5/13/02

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The tailings consist of phyllosilicates (clays), tectosilicates (predominantly feldspars and quartz), sulfides (mostly pyrite), iron oxides (magnetite, goethite, and ferric hydroxide), and calcium salts (gypsum and calcite). Most of the material is coarser than 325 mesh (44 microns). The tailings exhibit fines contents ranging from 60 to 95 percent. By comparison, Lacustrine sediments contain about 75 to 85 percent fines. Geotechnical data pertaining to the tailings material are presented in Appendix B.

Overlying the tailings is a soil cap fill comprised of silty sands, gravels and cobbles. It is believed that the majority of this material was obtained from the sloped areas to the south of the existing tailings location. The soil cover can be classified as gravelly sandy loam in texture according to the U.S. Department of Agriculture (USDA) textural classification system. Infiltration rate is approximated at 0.75 inches per hour (19.05 millimeters per hour [mm/hr]). This cover material currently functions like a sponge allowing significant infiltration. Vegetation on the cap is sparse consisting of primarily grasses with some willows along the south side near the September 2000 Borehole "C" location.

The soil cap and the undisturbed south hillside material exhibit fines contents of about 15 to 20 percent (BOR, 1990). Utilizing the topographic map of the McLaren tailings and 1989 and 2001 data from the borings, the volume of cover soil overlying the tailings impoundment is approximately 57,000 cubic yards (including the volume of the dam embankment).

ABA data was obtained in 1993 for the tailings impoundment for reclamation scenarios involving stabilization and revegetating in-place. The ABA results indicate that the tailings impoundment is considered a potential acid producer and approximately 1,100 tons of lime per acre would be required to successfully establish vegetation on this material, assuming a 12-inch depth of incorporation (see Table A-6 in Appendix A).

3.3 TAILINGS DAM

The tailings impoundment and embankment dam consist of mill tailings sediments, embankment and soil fills, and ore or waste rock piles that overlay Pleistocene age deposits. The tailings dam embankment consists of a silty sand, with considerable gravel with some sandy silt lenses. The embankment dam is approximately 400 feet long and 12 to 30 feet high. Crest width is about 10 feet and base width is about 50 feet (BOR, 1990). No additional data regarding the tailings dam were collected during the September 2001 investigation.

3.3.1 Old Stream Channel

During the 2001 site investigation, approximately 2,000 cubic yards of mine waste materials were observed in an old stream channel (OSC) or erosion gully located directly west of the tailings impoundment. Two samples of this material (OSC-1 and OSC-2) were collected and analyzed for total metals and ABA (see Figure 3-1). Results are shown on Tables A-5 and A-6 in Appendix A. The ABA and SMP buffering capacity results indicate that the waste type material is considered a potential acid producer. During reclamation activities at the site, it is recommended that this material be excavated and consolidated with other on-site wastes.

3.3.2 Potential Repository/Cover Soil Borrow Areas

Twelve test pits were excavated along the southern and eastern edge of the tailings impoundment by Pioneer on September 18, 2001. The majority of the test pits were excavated on land administered by the U. S. Forest Service (Gallatin National Forest). Along the eastern side of the tailings impoundment the test holes were excavated along a 4-wheeler trail as far back into the timber as possible. Test pit depths ranged from 40 inches to 96 inches, soil texture ranged from fine grained sand to silt. No groundwater was encountered in any of the test pits; however, BA1-11 was damp at a depth of 5 to 7 feet below ground surface. Table A-1 in Appendix A indicates the total depth of each test pit and gives a brief description of physical characteristics observed in each test pit.

Three composite samples were collected from the borrow area test pits for total metals, ABA, agronomic, and physical analyses (see Tables A-2, A-4, A-5, and A-6 in Appendix A). The potential repository/cover soil material consists of sandy clay loam. Organic amendment of this material is advised due to the very low organic matter content (<1 percent). The metals concentrations are comparable to the background soil samples collected and the ABA results indicate no potential for acid production. This area appears to meet cover soil requirements.

The area most conducive to construction of an on-site repository is located immediately southwest of the tailings impoundment on a timbered bench (discussed further in Section 7.0). Access to this area with a backhoe was not possible during the 2001 site investigation due to abundant standing timber; however, the borrow area soil samples collected along the eastern and southern edge of the tailings impoundment (on U.S. Forest Service land) are considered to be representative of the potential repository site. If the preferred alternative for the McLaren Tailings Site includes construction of an on-site repository in this location, additional samples should be collected to verify the available data and to investigate constructability issues.

3.4 SURFACE WATER AND SEDIMENT CHARACTERISTICS

In August 1993, Pioneer collected three paired surface water and sediment samples and two surface water seep samples as part of the state-wide abandoned mine inventory project. On September 20, 2000, Pioneer collected five additional paired surface water and sediment samples and two surface water seep samples as part of a supplemental site evaluation. Surface water/sediment sample locations are shown on Figure 3-5. Surface water and sediment samples were collected following the DEQ/MWCB Abandoned Mine Inventory SOPs. Each surface water sample was analyzed for total metals (TAL) and wet chemistry parameters (sulfate, chloride, hardness, and total dissolved solids [TDS]). Analytical results are included on Tables A-7 and A-8 in Appendix A.

3.4.1 Surface Water Chemistry Results

Water samples collected at the site were analyzed for total and/or total recoverable metals using the following multi-element suite: As, Ba, Cd, Co, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Sb, and Ag. In addition to metals, TDS, chloride, sulfate, nitrate, and hardness were analyzed. The surface water quality analytical results for the 1993 and 1990 sampling events are summarized on Table

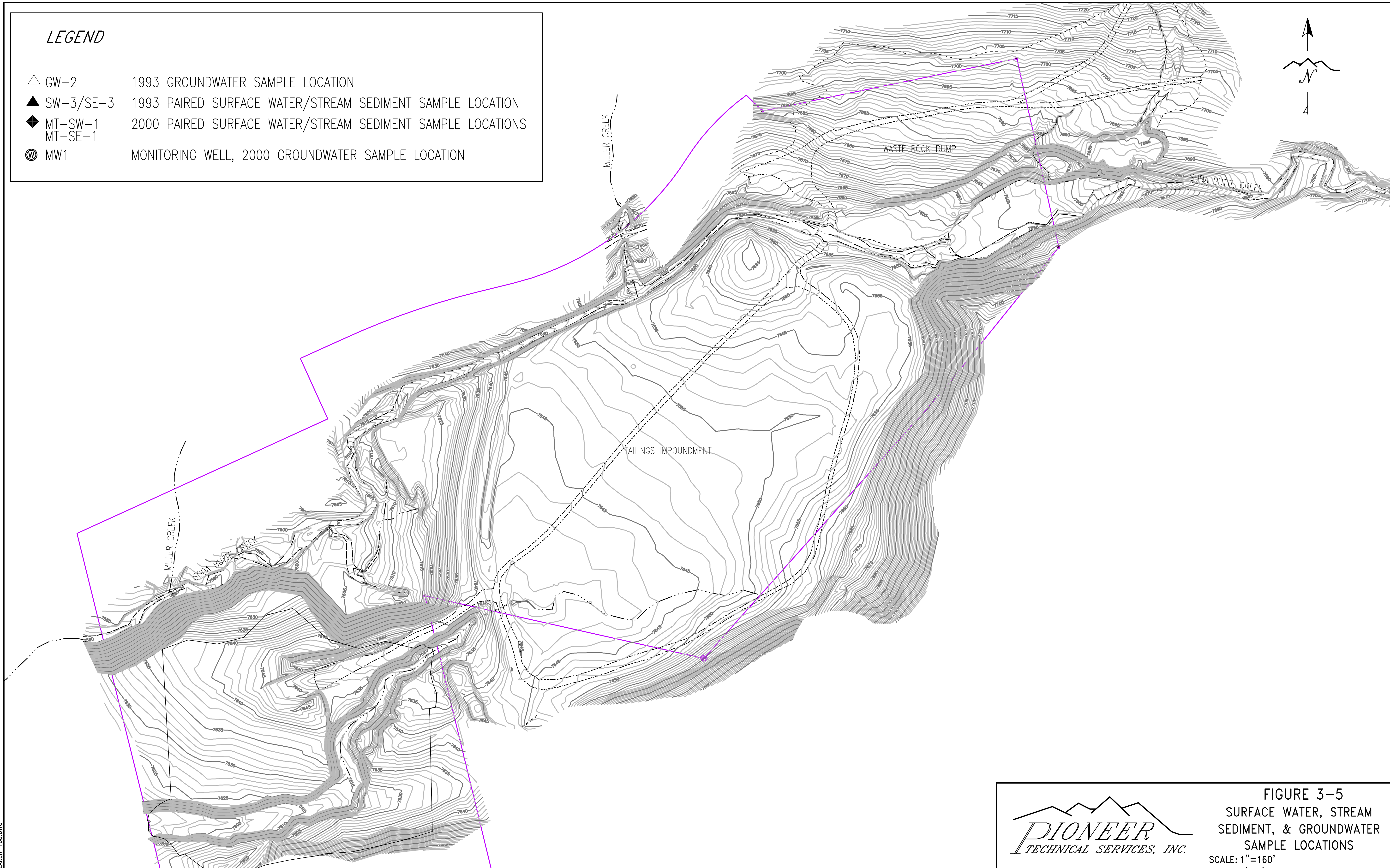

FIGURE 3-5
SURFACE WATER, STREAM SEDIMENT, & GROUNDWATER SAMPLE LOCATIONS
SCALE: 1"=160'
DATE: 5/13/02

MCLAREN-108.DWG

A-7 and A-8 in Appendix A.

One sample location from the 1993 investigation (SW-3/SE-3) and two sample locations from the 2000 investigation (MT-SW-3/MT-SE-3, and MT-SW-5/MT-SE-5) are located upgradient of all mine waste sources, including the old mill site. Water quality data indicate that Soda Butte Creek is being impacted by mine/mill wastes. As indicated on Table A-7, the only contaminant to exceed published water quality standards was Fe at three locations. Iron and Mn also exceeded secondary Maximum Contaminant Levels (MCLs) at these same locations. Wet chemistry results (see Table A-8) for TDS, chloride, sulfate and nitrate were within the applicable regulatory standards.

Water quality for the Miller Creek drainage at various locations (SW-2/SE-2 from 1993 and MT-SW-4/MT-SE-4 from 2000) is well within water quality standards.

A concentration analysis was performed using the 2000 data in an attempt at identification of the contributions to surface water and sediment from the sources present at the site. Significant increases of contaminants between two sample stations are indicative of contributions originating at a source located between the two stations. The analytical results are presented on Table 3-1, which allows a comparison between the sources for each contaminant.

TABLE 3-1
SIGNIFICANT SURFACE WATER AND SEDIMENT CONCENTRATION INCREASES
McLAREN TAILINGS

STREAM REACH	SOURCES WITHIN REACH	INCREASED CONTAMINANTS IN SURFACE WATER	INCREASED CONTAMINANTS IN STREAM SEDIMENTS
SW-5 to SW-3	Mill Site	Cd	Cd, Cu, Fe, Mn, Zn
SW-3 to SW-2	Tailings Discharges	As, Cd, +Fe, +Mn, Sulfate, TDS, SC, -pH	Ag, As, Cd, Cu, Fe, Mn, Pb, Zn
SW-2 to SW-1	Miller Creek	Alkalinity, pH, Sulfate	Mn

+ means that concentration significantly increased from previous station.
- means that concentration significantly decreased from previous station.

Elevated metals concentrations in surface water appear to be related to discharges from the tailings pond, both surface seeps and groundwater discharges.

3.4.2 Surface Water Loading Analysis

Surface water discharge was measured at each surface water station along Soda Butte Creek. This was done to perform a loading analysis to determine which sources were contributing the largest contaminant loadings to surface water. Loading increases can be used to identify which sources are causing the majority of the water quality degradation, and which could most effectively be mitigated to afford the greatest improvement in water quality.

Surface water contaminant loadings are a function of discharge (Q) and contaminant concentrations measured in water. Measured discharge in cfs and significant increases of calculated contaminant loadings are listed on Table 3-2.

TABLE 3-2
DISCHARGE VALUES AND CONTAMINANT LOADINGS IN SODA BUTTE CREEK McLAREN TAILINGS

STREAM REACH	SOURCES IN REACH	Fe LOAD (% SW2)	Mn LOAD (% SW2)	As LOAD (% SW2)	Cd LOAD (% SW2)
Above SW-5	None	0.3%	1.2%	35.6%	22.8%
SW-5 to SW-3	Mill Site	0.0%	-0.2%	-7.2%	29.3%
SW-3 to SW-2	Tailings Groundwater Discharge	56.0%	69.4%	67.2%	47.4%
SW-6	South Seep	43.7%	29.6%	3.8%	0.3%
SW-7	Center Seep	0.0%	0.1%	0.6%	0.1%
SW-4	Miller Creek Drainage	0.0%	0.1%	1.9%	3.3%

* Loadings are a function of flow rate (Q) and concentrations.

Table 3-2 indicates a significant Fe (44 percent) and Mn (30 percent) loading enters Soda Butte Creek via the discharge at SW-6 (seep located on the south side of tailings dam). Treatment or elimination of this discharge to Soda Butte Creek may significantly improve water quality. Also, significant Fe (56 percent), Mn (69 percent), As (67 percent), and Cd (47 percent) loading enters Soda Butte Creek between stations SW-3 and SW-2 via groundwater, even though the volume of water is relatively small (1 cfs).

A significant Cd (29 percent) loading enters Soda Butte Creek between stations SW-5 and SW-3. These loads are presumably due to the mill site input to surface water via remobilized streambed sediments.

3.4.3 Stream Sediment Chemistry Results

Three stream sediment samples were collected in August 1993 at the same locations as surface water samples. Five stream sediment samples were collected in September 2000 at the same locations as surface water samples. Sample locations are shown on Figure 3-4. Stream sediments were analyzed for the same multi-element suite of total metals as the surface water samples. Laboratory analytical results are summarized on Table A-5 in Appendix A.

Metals concentrations in stream sediments may be source-related, with solid phase metals released from the mill site during runoff events and dissolved metals from the tailings precipitating to sediment at SW-2 and SW-1. Copper concentrations are higher (>3X) in downgradient samples. Miller Creek appears unaffected.

3.5 GROUNDWATER

The quality of groundwater within the tailings impoundment is variable and depends on seasonal water level fluctuations and is highly dependent on the location within the tailings with respect to the proximity to the former Soda Butte Creek channel. The tailings groundwater generally exhibits a low pH, high SC, high sulfate concentrations, and highly dissolved and total recoverable Fe concentrations. Other parameters, which occasionally exhibit high concentrations, include Al, Pb, Cu, silica, and Zn (David Stiller & Associates, 1983).

Pioneer did not collect groundwater samples as part of the September 2000 or 2001 investigations; however, several previous investigations included groundwater sample collection and analyses (MBMG, 1975; David Stiller and Associates, 1983; DSL/AMRB-Pioneer, 1993). A back-calculation was performed using the loading data in Soda Butte Creek collected during the September 2000 investigation. This was performed to ascertain whether the loading increases in Soda Butte Creek are attributed to groundwater inflow by comparing the back-calculated (required) concentrations to observed groundwater concentrations. As indicated on Table 3-3, the groundwater concentrations required to account for the increases in contaminant loading in Soda Butte Creek are well within the observed historic concentrations measured in groundwater within the tailings. Consequently, attributing the increased loads in surface water to influent groundwater is reasonable.

TABLE 3-3
GROUNDWATER CONCENTRATIONS
McLAREN TAILINGS

	Cd (µg/L)	**Cu (µg/L)**	**Fe (µg/L)**	**Mn (µg/L)**	**Zn (µg/L)**	**Sulfate (mg/L)**
Historic groundwater average	14	9,300	2,300,000	2,000	1,270	7,200
*Back-calculated groundwater from loading differences in Soda Butte Creek	0.33	--	7,235	385	7.2	116
MT-SW-2 Soda Butte Creek below tailings	0.15	2.0u	2,820	121	14.7	39.7

*Back calculated numbers are based upon the September 2000 MT-SW-2 results.
µg/L – micrograms per Liter